Credit Rationing, Macro Volatility, and

Industrial Evolution in Developing Countries

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May 2008

Abstract

Relative to their counterparts in high-income regions, entrepreneurs in developing countries face less efficient financial markets, more volatile macroeconomic conditions, and higher entry costs. This paper develops a dynamic empirical model that links these features of the business environment to firm ownership patterns, firm size distributions, productivity distributions, borrowing patterns, and cross-household savings behavior. Applied to panel data on Colombian apparel producers, the model yields econometric estimates of a credit market imperfection index, the sunk costs of creating a new business, and various other parameters. It also provides a basis for several counterfactual experiments. These show, inter alia, that an efficient credit market would improve the weighted-average efficiency of producers by about 5 percent, partly by allowing the most productive producers to expand and partly by reducing the incentives for inefficient firms to remain in the market. The gains from better intermediation accrue mainly during periods of macro volatility, and mainly to households with modest wealth but high entrepreneurial ability.

JEL categories: O16, L26, D24

I.   Overview

Relative to their counterparts in high-income regions, entrepreneurs in developing countries face less efficient financial markets, more volatile macroeconomic conditions, and higher entry costs.[1,2, 3] This paper develops a dynamic empirical model that links these features of the business environment to firm ownership patterns, firm size distributions, productivity distributions, and borrowing patterns.

The model emphasizes several basic effects. First, borrowing constraints force households with modest collateral to either forego profitable entrepreneurial activities or pursue them on an inefficiently small scale. Second, since credit constraints limit households' ability to smooth their consumption streams, those with relatively less tolerance for risk shy away from business ventures during periods of macro volatility.[4] Finally, in combination with substantial entry costs and a significant spread between borrowing and lending rates, uncertainty about future business conditionscreates an incentive for entrepreneurs to continue operating their firms when profits turn negative. Combined, these effects make firms' survival and growth less

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[1] Private credit is scarce (as a share of GDP), spreads between borrowing and lending rates are large, non-bank intermediation is relatively unimportant, and equity markets are often almost non-existent. The literature documenting these patterns of financial development is vast; Beck et al (2000) provide a cross-country data set that reflect the characteristics mentioned here. Levine (2005) surveys the evidence linking these features of financial sectors (among others) to countries' aggregate growth rates. Djankov et al (2006) empirically link the poor performance of credit markets in developing countries to their lack of legal creditor protections and information-sharing institutions.

[2] Loayza et al (2007) survey the literature on macroeconomic volatility in developing countries and discuss its causes and costs. Kaminsky and Reinhardt (1999) document patterns of banking and financial crises in developing countries. Tybout (2000) provides additional references and notes that Latin America and Sub-Saharan Africa stand out among the developing countries as the most volatile, but all developing regions do worse than the industrialized countries.

[3] Surveying entry regulations in 85 countries, Djankov et al (2002) conclude that "business entry is extremely expensive, especially in the countries outside the top quartile of the income distribution." (p. 25)

[4] Volatility can also change the types of capital goods that entrepreneurs invest in, as in Lambson (1991) and Aghion, et al (2005). Our analysis does not deal with this phenomenon.

dependent upon their owners' entrepreneurial ability, and more dependent upon their owners' wealth and market-wide volatility.

We fit our model to plant-level panel data and macro data from Colombia, obtaining econometric estimates of plant-level profit functions, the sunk cost of creating a new business, and an index of credit market imperfections (inter alia). Then, using our estimated parameters, we simulate industrial evolution patterns under alternative assumptions about credit market imperfections. In particular, we explore the effects of credit market imperfections and volatile macro environments on entry and exit patterns, cross-firm investment patterns, industry-wide productivity distributions, and savings.

The simulations yield a number of findings. First, the credit markets in which small-scale Colombian entrepreneurs operate are subject to severe enforcement problems. These problems interact with macro volatility, substantial entry costs, and risk aversion to discourage households with modest wealth from investing in proprietorships—even those with high earnings potential. Second, if enforcement problems were eliminated so that firms were not required to self-finance their investments, those with relatively modest wealth but high earnings potential would expand significantly relative to others. Also, the option value of remaining in business would fall for firms with low earnings rates, and some of these would exit. Combined, these two effects would improve industry-wide productivity by about 5 percent. Third, households with promising business opportunities and modest wealth would be the main beneficiaries of better-functioning credit markets, and their gains would be the most striking during periods of relative macro volatility. Finally, if Colombia were to reduce the spread between its borrowing rate and its lending rate, wealthy households would shift their portfolios away from businesses investments toward the financial sector, increasing size-weighted average productivity by more than 3

percent.

Our study is distinctive in that we econometrically estimate a dynamic structural model of entrepreneurship with uncertainty and endogenous borrowing constraints. However, it shares a focus on entrepreneurship, borrowing constraints and wealth heterogeneity with a number of dynamic general equilibrium models, including Banerjee and Newman (1993, 2001), Aghion and Bolton (1997), Lloyd-Ellis and Bernhardt (2000), Giné and Townsend (2004), and Cagetti and De Nardi (2006). And it resembles Townsend and Ueda (2006) and Greenwood and Jovanovic (1990) in that it characterizes the choices of risk-averse households between a risky business venture that is subject to idiosyncratic shocks and a financial asset that is subject only to market-wide shocks.

The model we develop is also consonant with many of the main messages that emerge from the micro empirical literature on entrepreneurship and credit market imperfections. These include findings that small scale entrepreneurs in developing countries are credit-constrained (Del Mel et al, 2007; Banerjee and Duflo, 2005; Paulson and Townsend, 2004), that wealthy households are more likely to own businesses (Evans and Jovanovic, 1989; Evans and Leighton, 1989; Fairlie, 1999; Quadrini, 1999; Gentry and Hubbard, 2004; Hurst and Lusardi, 2004; Cagetti and de Nardi, 2006), and that the correlation between wealth and entrepreneurship partly reflects lower absolute risk aversion among the wealthy (Hurst and Lusardi, 2004).

Finally, our paper is related to several single-agent models of industry dynamics. These include Cooley and Quadrini's (2001) model of risk-neutral firms' investment behavior with credit constraints (based on costly state verification), Bloom's (2007) model of firms' input choices in the face of convex adjustment costs and uncertainty, and Buera's (2008) deterministic model of entrepreneurial behavior subject to a leverage constraint.

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II.   The Model

Several basic assumptions underpin our model. First, securities markets are negligible and households must hold their wealth as bank deposits and/or investments in proprietorships. Second, households can borrow to finance some of their business investments, but their loans must be sufficiently small that they pose no default risk to lenders. Third, households are forward-looking, infinitely-lived, and risk-averse. Fourth, households are also heterogeneous in terms of their ability to generate business income, which is subject to serially correlated, idiosyncratic shocks. Fifth, all firms produce traded goods, so changes in the real exchange rate result in changes in their output prices. Finally, exchange rates and interest rates evolve jointly according to an exogenous Markov process. We now turn to specifics.

A.   The Macro Environment

Three macro variables appear in our model—the real exchange rate, e, the lending rate, r, and the deposit rate, $r - \mu$. The interest spread $m > 0$ is parametrically fixed, so we can summarize the state of the macro economy at any point in time by the vector $s_t = \begin{pmatrix} e_t \\ r_t \end{pmatrix}$, which we assume evolves according to an exogenous Markov process: $y(s_{t+1} \mid s_t)$.

B.   The Household Optimization Problem

Households fall into one of three categories: incumbent owner-households (I), potential owner-households (P), and non-entrepreneurial households (N). Incumbent owner-households currently own firms, and must decide each period whether to continue to operating them or exit. Those who exit become non-entrepreneurial households. Those who remain in the industry must further choose their output levels, capital stocks, and debt/equity ratios (subject to borrowing

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constraints).

Potential owner households are not currently in the industry, but do have "ideas" of various qualities on which they could base new firms. These households can create a firm in the current period by paying a sunk entry cost; those that do so discover the value of their ideas and decide thereafter whether to initiate production. Ideas arise randomly at an exogenous rate.

Non-entrepreneurial households do not currently operate a firm or have a business idea, so they need only make a consumption/saving decision in the current period. (They hold all of their wealth as bank deposits, and since the deposit rate is less than the lending rate, they have no incentive to borrow.) Next period, however, they may be struck with a new idea and become a potential entrant—this happens with exogenously-given probability. Possible transitions between the household types are summarized by figure 1.

All households are characterized by a constant relative risk aversion (CRRA) utility function, $U(c_{it}) = \dfrac{(c_{it})^{1-s}}{1-s}$, where c_{it} is consumption by household i at time t. Each period, households choose their savings rates, next-period types (if they are incumbent- or potential-owners), and business investments (if they are incumbent-owners). They make these decisions with the objective of maximizing their discounted expected utility streams, $E_t \sum_{t=t}^{\infty} U(c_{it}) b^{t-t}$, subject to borrowing constraints. (Here E_t is an expectations operator conditioned on information available in period t, and b is a discount factor that reflects the rate of time preference.) Outcomes are uncertain because the macro economy evolves stochastically, and because owner-households experience idiosyncratic shocks to the return on their business investments.

Non-entrepreneurial households

The programming problem faced by non-entrepreneurial households is the simplest, since they only decide how to allocate their current income between consumption and savings. Let a_{it} denote the wealth held by household i at the beginning of period t, and let its exogenous non-asset income be y_0. Consumption by non-entrepreneurial household i in period t is $c_{it} = y_0 + (r_t - m) \cdot a_{it} - (a_{it+1} - a_{it})$. In the following period, the household becomes a potential entrant household with probability p.

In period t, non-entrepreneurial household i maximizes the expected present value of its utility stream by choosing the savings rate $a' - a_{it}$. The resulting expected present value is

$$V^N(a_{it}, y_0, s_t) = \max_{a' \geq 0} \big[U(y_0 + (r_t - m)a_{it} - (a' - a_{it})) +$$

$$+ b \sum_s y(s'|s_t) \big(p V^P(a', y_0, s') + (1-p) V^N(a', y_0, s') \big) \big] \qquad (1)$$

Here $V^P(a,y,s)$ is the value function for a potential entrant household (discussed below), and the constraint $a' \ni 0$ reflects our assumption that households are unable to borrow against their non-asset income.

Incumbent owner households

Owner-households face a more complicated programming problem because they must choose whether to continue operating their proprietorships and—given that they continue—how much of their wealth to hold as investments in their firms. The business income (before fixed costs and interest payments) generated by household i's proprietorship is:

$$p(k_{it}, e_t, n_{it}), \ p_k > 0, p_{kk} < 0, \ p_e < 0, \ p_n > 0, \qquad (2)$$

where k_{it} is the firm's stock of productive assets and n_{it} is an idiosyncratic shock that captures

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managerial skills and investment opportunities. We assume that $<_{it}$ evolves according to the discrete Markov process $f(n_{it+1} | n_{it})$ that it is independent of the macroeconomic state vector s_t.

Several features of the function (2) merit comment. First, business income is decreasing in e because we treat an increase in the exchange rate as an appreciation, which makes imports cheaper and reduces the return to exporting. Second, firms' incomes are not affected by the behavior of their domestic competitors because we assume that each firm's product has many substitutes in foreign markets, making the effects of entry, exit or price adjustments by domestic producers insignificant. Finally, diminishing returns to productive assets, $p_{kk} < 0$, reflect finite demand elasticities for each product, and may capture span-of-control effects as well.

Owner-households can invest all of, more than, or less than their entire wealth in their business's asset stock. If household i invests all of its wealth in its firm and borrows nothing, $a_{it} = k_{it}$. If it invests less than all of its wealth, it holds the balance $a_{it} - k_{it}$ as bank deposits, which yield $r_t - m$. If it invests more than its wealth, it must satisfy the no-default constraint (to be discussed), and it finances the excess $k_{it} - a_{it}$ with a loan at rate r_t.[5] Combining these possibilities, the ith household earns or pays out $(a_{it} - k_{it}) \cdot (r_t - m D_{it})$ in interest during period t, where $D_{it} = \begin{cases} 1 \ if \ a_{it} - k_{it} > 0 \\ 0 \ otherwise \end{cases}$ is a dummy variable indicating whether households hold bank deposits. Accordingly, its period t consumption is

$c_{it} = y_0 + p(k_{it}, e_t, n_{it}) - f + (r_t - m D_{it}) \cdot (a_{it} - k_{it}) - (a_{it+1} - a_{it})$, where f is the per-period fixed cost of operating a business.

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[5] Households never borrow to acquire bank deposits because, with $m > 0$, this amounts to giving money away to the bank.

Given the above, the expected present value of owner-household i's utility stream is determined by its beginning-of-period wealth, a_{it}, its idiosyncratic profitability shock, n_{it}, and the macroeconomic state, s_t. If the household sells off its productive assets, pays off its debts, and shuts down its firm, it reaps the expected utility stream of a non-entrepreneur, $V^N(a_{it}, y_0, s_{it}, p)$. Alternatively, if it continues to operate, it reaps current utility $U(y_0 + p(k_{it}, e_t, n_{it}) - f + (r_t - mD_{it}) \cdot (a_{it} - k_{it}) - (a_{it+1} - a_{it}))$ and it retains the option to continue producing next period. Accordingly, the unconditional expected utility stream for an owner-household in state (a_{it}, s_t, n_{it}) when the firm is able to borrow as much as it wants at the rate r finance as much as it wants at rate r_t to finance its capital investment is:

$$V(a_{it}, y_0, s_t, v_{it}) = \max\left[V^I(a_{it}, y_0, s_t, v_{it}), V^N(a_{it}, y_0, s_t, p)\right] \tag{3}$$

where

$$V^I(a_{it}, y_0, s_t, v_{it}) =$$

$$\max_{a' \geq 0, k_{it} > 0}\left[U(y_0 + p(k_{it}, e_t, v_{it}) - f + (r_t - mD_{it})(a_{it} - k_{it}) - (a' - a_{it})) + \right.$$
$$\left. b \sum_{n'} \sum_{s'} V(a', y_0, s', n') \cdot y(s'|s_t) \cdot f(v'|n_{it}) \right], \tag{4}$$

We model the capital market imperfection by assuming that, while lenders are perfectly informed about the current profitability of the borrower's firm, n_{it}, they are unable to observe the uses to which these borrowers puts their loans. If the ith household borrows an amount ($k_{it} - a_{it}$), its can either invest that amount in the firm or sell the firm's capital stock and abscond with $q\, k_{it}$. The parameter $q \in [0,1]$ captures all of the monetary and psychic costs of taking the money and

running, including the possibility of future punishment. Owner-households that shut down their firms by defaulting will simply earn the return of a non-entrepreneurial household with assets $q\,k_{it}$ that is denied access to credit markets and cannot re-enter the industry in the future. The no default constraint thus requires that the entrepreneur earn no less by continuing to operate the firm than could be earned by default:

$$V^I(a_{it}, y_0, s_t, n_{it}) \geq V^N(q k_{it}, y_0, s_t, 0) \qquad (5)$$

Wealthy households satisfy this constraint at higher borrowing ($k_{it} - a_{it}$) levels because they stand to lose more in the event of default, so household wealth acts as collateral.[6] The limiting cases of $q = 0$ and $q = 1$ correspond to perfectly enforceable debt contracts and costless default, respectively.

This formulation captures two senses in which household wealth facilitates the financing of firms. First, the wedge : between the borrowing and lending rate for firms makes it more attractive for households to accumulate assets because of the higher return available when $a_{it} < k_{it}$. Second, increases in household wealth relax the no default constraint in (5).

Potential owner-households

We conclude our description of our model by characterizing industry entry. Each period, an exogenous number of households become potential owner-households. Those that choose to enter pay start-up costs, F, and draw an initial v_{it} from the distribution $q_0(v)$. Given this v_{it}, each entrant chooses initial k_{it} and $a_{it+1} - a_{it}$ values, subject to the relevant no-default constraint.

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[6] Borrowing constraints of this type have been used by Banerjee and Newman (1993, 2001) and Cagetti and Di Nardi (2006) to examine the role of capital market imperfections. Like these authors, we abstract from costly state verification and imperfect observability—this gives us a credit constraint that captures contract enforceability problems and is simple enough to permit econometric estimation.

Potential entrant households that choose *not* to enter return to being a non-entrepreneurial households and allocate their current income of $y_0 + (r_t-\mu)a_{it}$ between consumption and asset accumulation in the form of bank deposits.

If household i creates a firm with profitability n_{it} and capital stock k_{it} in period t, and if it saves $a' - a_{it}$, the present value of its expected utility stream will be:

$$\widetilde{V}^P(a_{it}, y_0, s_t, k_{it}, a' \mid n_{it}) = U\big(y_0 - F + p(k_{it}, e_t, n) - f + (r_t - mD_{it}) \cdot (a_{it} - k_{it}) - (a' - a_{it})\big) +$$
$$+ b \cdot \sum_{n'} \sum_{s} V(a', y_0, e', r', n') \cdot y(s' \mid s_t) \cdot f(n' \mid n_{it}) \qquad (6)$$

Accordingly, the value of entry to a household with assets a_{it} and exogenous income y_0 is:

$$V^P(a_{it}, y_0, s_t) = \sum_{n} \max_{a' \geq 0, k_{it} > 0} \widetilde{V}^P(a_{it}, y_0, s_t, a', k_{it} \mid n) q_0(n)$$

subject .to

$$\widetilde{V}^P(a_{it}, y_0, s_t, a', k_{it} \mid n) > V^N(qk_{it}, y_0, s_t), \qquad (7)$$

and it will create a new proprietorship if:

$$V^P(a_{it}, y_0, s_t) > V^N(a_{it}, y_0, s_t), \qquad (8)$$

Note that the value of entry is not conditioned on v_{it} because the firm's productivity is only observed after the entry cost has been incurred.

Potential entrants might choose not to enter for two reasons. One is that the current macroeconomic state makes entry unattractive. The other is low initial wealth holdings.

In the absence of borrowing constraints, the functional equations (1), (4), (6) and (7) would be a contraction mapping in the functions V^N, V^P and V^I and there would be a unique solution for the value functions of the respective household types. However, when the borrowing constraint is imposed, the functional equations are no longer a contraction because the

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value functions appear in the constraint. Multiple equilibria can arise in this case because beliefs can be self-fulfilling. (Expectation of a low value for the firm will make the no default constraint more binding and will reduce the amount the firm can borrow.) Using Rustichini's (1998) approach, we identify the solution in which values are at their maximum.[7]

C. Industry Evolution

The solution to the owner-household programming problem (3)-(5) yields a policy function $\tilde{a}(a_{it}, s_t, \mathsf{n}_{it})$ for incumbent households' asset accumulation, and an indicator function $\mathsf{c}(a_{it}, s_t, \mathsf{n}_{it})$ that is equal to one for those households that sell their businesses. Similarly, the solution to the potential entrepreneur's programming problem (6)-(7) yields a policy function $\tilde{a}^P(a_{it}, s_t)$ for potential owner-households' asset accumulation and an indicator function $\mathsf{c}^N(a_{it}, s_t)$ that is equal to one for those potential-owner households that create new firms. Once the model's parameters have been estimated, these policy functions provide the basis for simulations discussed in section IV below.

III. Fitting the model to data

Our estimation strategy is dictated partly by data availability. Matched employer-employee data are generally not available in developing countries, and the household surveys that do exist are not very informative about the businesses that entrepreneurial households operate. We therefore estimate our model using macro time series and plant-level panel data.

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[7] Specifically, we first solve the model for the special case in which credit markets function perfectly, which is a contraction mapping. Then we use the values from perfect credit market case as initial guesses for the constrained value function, and we iterate downward until the borrowing constraint is satisfied. This approach ensures that we always identify the value-maximizing equilibrium.

More precisely, we fit our model to macro data and micro panel data on apparel producers in Colombia. The Colombian macro environment suits our purposes because it exhibited major changes in real exchange rates and real interest rates during the past 25 years, and thus should have induced the type of variation in behavior that is needed to identify parameters. The Colombian regulatory environment suits our purposes because creditors have limited rights to seize collateral in this country, and bureaucratic barriers to entry are substantial.[8] Finally, the apparel industry suits our purposes because apparel is highly tradable and because its minimum efficient scale is relatively low. Tradability is necessary if prices are to be determined in global markets, as the model presumes, and modest scale economies are necessary to ensure monopolistic competition and large numbers of closely-held firms.

A. Estimating the Markov process for macro variables

To estimate the joint transition density for interest rates and exchange rates, $j\,(s_{t+1}\,|\,s_t)$, we use the longest quarterly s_t series available, which spans the period 1982I through 2007II. As figure 2 demonstrates, this period began with several years of low interest rates and a strong peso; thereafter, the exchange rate regime collapsed, triggering a major devaluation and a sharp increase in interest rates.[9] During the ensuing post-collapse period the exchange rate gradually regained strength. But shortly into the new century the peso lost value and interest rates appeared

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[8] The World Bank (2008) gives Colombia a score of 2 on a 10-point scale for the strength of the legal rights enjoyed by its creditors. Out of 178 economies, including 24 OECD "benchmark countries," this study ranks Colombia 84th in terms of credit access. In terms of "ease of starting a business" it ranks Colombia 88th in the world. More specifically, the Bank reports that "it requires 11 procedures, takes 42 days, and costs 19.32 percent of GNI per capita to start a business in Colombia." (p. 10).

[9] Kaminsky and Reinhardt (1999) document similar patterns in their study of 20 crisis-prone countries: periods of appreciation and low interest rates are followed by periods of depreciation with higher interest rates. In the Colombian context, the major changes in the macro environment reflected associated changes in global coffee prices, global oil prices, international credit conditions, and Colombian policy decisions. For descriptions of these shocks and the associated policy responses, see Edwards (2001), Garcia and Jayasuriya (1997), and Partow (2003).

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to realign once again.

These trajectories suggest that a regime-switching model might do a good job of approximating the transition density, $j\,(s_{t+1} \mid s_t)$. Such models presume that the variables of interest obey different vector autoregressions (VARs) at different points in time, with switches between the VARs governed by a function to be estimated. [10] Some switching models treat the probabilities of regime changes as exogenous, some treat these probabilities as a function of exogenous variables, and some treat regime changes as triggered by the movement of an element of the VAR across a threshold. We opt for the latter type of model, known as a "self-exciting threshold autoregression" (SETAR), because it allows the probability of a regime change to build when macro conditions are unsustainable, as for example, when exchange rate policy leads to an increasingly strong currency. Also, unlike the second type of switching mentioned above, the SETAR model allows the triggering variable itself to switch processes.

To implement the SETAR model, we assume the economy is in one of two macro regimes at any point in time. When regime $m \in \{1,2\}$ prevails, s_t evolves according to $s_t = b_0^m + b_1^m s_{t-1} + u_t^m$, where $E\left(u_t^m u_t^{m'}\right) = \Sigma^m$. Regime switches are triggered when one of the elements of the vector s—the interest rate, in our case—crosses an estimated threshold value. Estimates of this specification are reported in Table 2. They imply that the economy is regime 1 when the real interest rate is below 9.4 percent, and in regime 2 otherwise. Also, the point estimates imply stable processes for in both regimes, but real interest rates are substantially

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[10] Applications of regime-switching models to exchange rates include Engel and Hamilton (1990) and Bollen, et al (2000). Applications to interest rate processes include Gray (1996). We are unaware of papers that apply switching estimators to the joint evolution of exchange rates and interest rates, although Chen (2006) estimates an exchange rate switching model in which the interest rate affects the probability of a regime switch but does not enter the VAR directly. The methodology for estimating multivariate switching models is nonetheless well developed (e.g., Clarida *et al*, 2003).

higher in the second regime, and the peso tends to be weaker. [11] Finally, simulations of the estimated SETAR show that the unconditional variance of the exchange rate process is higher in regime 1, while the unconditional variance of the interest rate process is roughly the same in both regimes. Thus, other things equal, risk aversion will make households prefer regime 2, and indebtedness will make households prefer regime 1. We examine the question of which effect dominates for different types of households in section IV below.

It remains to estimate the spread between the lending rate and the deposit rate, :. We identify this parameter as the mean difference between these two series over the sample period: :=0.060. This figure is not unusual for Latin American economies, but it is several percentage points higher than the spreads typically found in high-income countries (Beck et al, 2000).

B.   Estimating the profit function

To obtain estimates of the operating profits function, $\mathsf{p}(k_{it}, e_t, \mathsf{n}_{it})$, and the transition density for profit shocks, $f(\mathsf{n}_{it+1} | \mathsf{n}_{it})$, it is necessary to impose additional structure on the model. First, let the production function for firm i be $Q_{it} = \exp(u_{it}) \cdot k_{it}{}^{\mathsf{a}} l_{it}{}^{\mathsf{g}}$, where u_{it} is a productivity index and l_{it} is an index of variable input usage—labor, intermediates, and energy. Next, assume that each firm sells a single differentiated product in the global marketplace, where it faces a demand function of the form $Q_{it}^{d} = A_{it} p_{it}{}^{-\mathsf{w}}$. Here $\mathsf{w} > 1$ is the elasticity of demand, and A_{it}, which is exogenous from the perspective of individual producers, collects all market-wide

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and idiosyncratic forces that shift demand for the ith firm's product.[12] Finally, let the ith firm face exogenous price (w_{it}) for a unit bundle of variable inputs, and assume that it chooses the associated profit-maximizing quantity and ouput price.

Given these assumptions, total revenue (G_{it}) and total variable cost (C_{it}) are:

$$G_{it} = t^{\,g(w-1)/k}\, A_{it}^{1/k}\, \exp\!\left(\frac{u_{it}(w-1)}{k}\right) w_{it}^{-g(w-1)/k}\, k_{it}^{a(w-1)/k}, \qquad (9a)$$

$$C_{it} = t^{\,w/k}\, A_{it}^{1/k}\, \exp\!\left(\frac{u_{it}(w-1)}{k}\right) w_{it}^{-g(w-1)/k}\, k_{it}^{a(w-1)/k}, \qquad (9b)$$

where $k = w(1-g) + g$ and $t = \dfrac{g(w-1)}{w}$. Conveniently, productivity shocks (u_{it}), the demand shifter (A_{it}), variable factor prices (w_{it}), and capital stocks (k_{it}) enter (9a) and (9b) in the same way, so cross-equation restrictions help to identify parameters, and the ratio of variable costs to revenues is simply $t < 1$.

Since the demand shifter, the productivity shock, and the factor price index are unobservable at the firm level, we let $A_{it}^{1/k}\, \exp\!\left(\dfrac{u_{it}(w-1)}{k}\right) w_{it}^{-g(w-1)/k}$ be a Cobb-Douglas function of the real exchange rate and serially correlated firm-specific shocks. Further, to allow for discrepancies between book values and true values, we assume that the log of observed variable production costs ($\ln C^m$) differs from the log of "true" costs ($\ln C$) by the measurement error z^C.[13] Then, defining $\underline{n}(s_t, a_{it})$ to be the minimum profit shock at which a firm continues

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[12] This characterization of demand is consistent with CES preferences over product varieties, frictionless trade, and the assumption that each firm supplies an insignificant fraction of the global apparel market.

[13] Among other things, this discrepancy reflects the fact that some wages are overhead expenses rather than variable production costs, inventory accounting does not accurately reflect the opportunity cost of inputs, and some costs that

operating (as implied by the dynamic programming problem in section II above), the following system of equations provides a basis for identification of profit function parameters and the transition density $f(\mathsf{n}_{it+1} \mid \mathsf{n}_{it})$:

$$\ln G_{it} = \mathsf{h}_0 + \mathsf{h}_1 \ln e_t + \mathsf{h}_2 \ln k_{it} + \mathsf{n}_{it} \tag{10a}$$

$$\ln C_{it}^m = \mathsf{h}_0 + \ln t + \mathsf{h}_1 \ln e_t + \mathsf{h}_2 \ln k_{it} + \mathsf{n}_{it} + z_{it}^C \tag{10b}$$

$$\mathsf{n}_{it} = \mathsf{l}\, \mathsf{n}_{it-1} + \mathsf{e}_{it} \tag{10c}$$

$$\mathsf{c}_{it} = 1[\mathsf{n}_{it} > \underline{\mathsf{n}}(s_t, a_{it})] \tag{10d}$$

Here $\mathsf{e}_{it} \sim N(0, \mathsf{s}_{\mathsf{e}}^2)$, and $z_{it}^C \sim N(0, \mathsf{s}_{\mathsf{z}}^2)$ are assumed to be i.i.d., serially uncorrelated shocks.

Note also that by equations (10a) and (10b), true operating profits before interest payments may be written as:

$$\mathsf{p}(k_{it}, e_t, \mathsf{n}_{it}) = (t^{-1} - 1)\exp(\mathsf{h}_1 e_t + \mathsf{n}_{it}) \cdot (k_{it})^{\mathsf{h}_2} - \mathsf{d}k_{it},$$

where * is the rate of depreciation.

Selection bias and simultaneity bias complicate estimation of the parameters in (10a-d). The former problem arises because current period capital stocks are chosen after the current period productivity shock is observed.[14] The latter problem arises because firms that draw very low productivity shocks shut down (by 10d), and the shutdown point is different for firms with

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are recorded as overhead may vary with production levels. Since sales revenue (G) is straightforward to record and much less subject to measurement error we do not allow for errors in the values of this variable.

[14] This is true in Olley and Pakes (1996) as well, but they assume that output is a function of previous period capital stocks, so they do not need to deal with this type of simultaneity bias.

different capital stocks.[15] We develop a moments-based estimator related to Olley and Pakes (1996) that deals with both problems. Details are provided in appendix 1.

Table 1 reports estimates of the profit function, the transition density $f(n_{it+1}|n_{it})$, and the rate of depreciation, $*$. The profit function and transition estimates are obtained by fitting the system (10a-d) to data on the population of apparel producers appearing in the annual manufacturing survey for a least two consecutive years between 1981 and 1991. The depreciation rate is constructed as the simple average across all observations on active firms of current depreciation expenses to capital stocks.

The estimates are generally quite plausible. At 0.61, capital's marginal revenue product is substantial, but it implies diminishing returns to capital investment—either because of finite demand elasticities in product markets or span of control problems.[16] The exchange rate coefficient implies each percentage point of appreciation reduces earnings, costs and profits by about 0.37 percent points. Plant-specific profitability shocks exhibit strong serial correlation—the root of this process is around 0.90, and is highly significant. Finally, the difference between the revenue function intercept and the cost function intercept implies that firms keep about 20 cents of each dollar of revenue as gross operating profit.

C.   Estimating the remaining parameters

Estimation strategy

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[15] Big firms continue operating at relatively low n_{it} values because the difference between firms' continuation values and their scrap values is increasing in n_{it} and k_{it} (Olley and Pakes, 1996).

[16] Since Bloom (2007) assumes constant returns to scale and a mark-up of .33, the elasticity of revenue with respect to scale in his model is approximately 0.75. Calibrating to U.S. data spanning all forms of business, and assuming competitive product markets, Cagetti and Di Nardi (2006) estimate the elasticity of output or revenue with respect to scale at 0.88.

A number of parameters remain to be estimated. These include the sunk entry cost, F, the per-period fixed operating cost, f, the credit market imperfection index, λ, the probability that a former entrepreneur encounters a new business opportunity, p, the risk aversion parameter, σ, exogenous household income, y, the average log wealth among new entrepreneurial households, $\overline{\ln a_0}$, the variance in log wealth among new entrepreneurial households, $s^2_{\ln a_0}$, and the ratio of total productive assets to fixed capital, θ.[17] These parameters, hereafter collectively referenced as $\Lambda = (F, f, \lambda, p, \sigma, y, \overline{\ln a_0}, s^2_{\ln a_0}, \theta)$, are estimated using the simulated method of moments.[18]

The logic behind the estimator is as follows. Taking $p\left(k_{it}, e_t, n_{it}\right)$, $f(n_{it+1} \mid n_{it})$ and $j\left(e_{t+1}, r_{t+1} \mid e_t, r_t\right)$ as given, one can numerically solve the programming problems in section II at any feasible Λ value.[19] Then, using the resulting policy functions, one can simulate the cross-firm distribution of capital, profits, productivity, and debt for the apparel sector as it evolves through time. Defining $m(\Lambda)$ to be a vector of moments that summarizes these joint distributions and their evolution, the discrepancy between these simulated moments and their sample-based counterparts, $\overline{m}$, can be can measured as $X(\Lambda) = \left(\overline{m} - m(\Lambda)\right)' W\left(\overline{m} - m(\Lambda)\right)$, where W $= \left[E\left(\overline{m} - m(\Lambda)\right)\left(\overline{m} - m(\Lambda)\right)'\right]^{-1}$ is an efficient weighting matrix. Our estimator is $\hat{\Lambda} = \arg \min X(\Lambda)$. Standard errors are bootstrapped.

Several issues arise in simulating $m(\Lambda)$. First, we must discretize the state space involved

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[17] We express asset stocks in logs to better deal with skewness. The parameter θ is included in Λ because our survey data only report fixed capital stocks, but conceptually, k includes all productive assets.

[18] The discount factor β is not included in Λ because our model does not provide much basis for its identification. Accordingly, we follow convention and fix it exogenously using the average interest rate implied by the SETAR process : $\beta = 1/(1+0.142) = 0.875$.

in order to use standard solution techniques for solving firms' dynamic optimization problems. For the macro variables and the profit shocks, which are jointly normally distributed, we apply Tauchen and Hussey's (1991) quadrature rules to the estimated transition densities.[20] For capital stocks and asset values, we create a discrete grid based on observed distributions.[21]

Second, we need an algorithm for searching 7 space. The function $X(\Lambda)$ is neither smooth nor concave, so gradient-based algorithms fail to identify global minima. We have experimented with pattern search algorithms and simulated annealing; the results discussed below are based on simulated annealing, repeated using different initial values to ensure robustness.

Third, we must construct an initial cross-household distribution for the profitability shocks, n_{it}. We base this distribution on the steady state distribution for the profitability shocks from our estimated of profit function. Fourth, since the data set does not report firms' borrowing levels, we must impute total debt for each observation. We do so using total interest payments (which *are* reported) divided by the market lending rate. Finally, it is necessary to make some assumptions about the number of households that might potentially start new apparel firms in each period. We assume that in the initial period there are 300 owner-households and we assume that 200 new households appear in the population of potential entrepreneurs each period. These figures essentially serve to fix the number of active firms.[22]

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[20]In the case of macro variables, we also must convert quarterly transition probabilities to annual transition probabilities by compounding the former.

[21] We used 75 discrete points for each of capital and asset values. To make the model solve quickly enough for econometric estimation, we use 5 discrete points for exchange rate, 5 for interest rate and 5 for profitability. There is a little sensitivity in the solution to the capital and asset discretization, but qualitatively the solution does not change.

[22] Let I_0 be the number of owner-households in period 0, and let N be the number of new households we add to the population each period. Then if the fraction of new households that creates firms is e and the fraction of owner-households that shuts down its firms every period is x, the population of owner-households in period t is

Estimates

Table 3 reports 7 estimates in the upper panel; the simulated moments that they imply are juxtaposed with corresponding data-based moments in the lower panel. Overall, the model does a good job of replicating the main features of our panel of apparel firms, including their size distribution, profit distribution, entry and exit rates, and borrowing patterns. All simulated moments except for one have the same sign as their sample counterparts, and most are close in magnitude.

Turning to the key parameters, sunk entry costs (measured in 1977 Columbian pess) are exp(6.8873) = 979,753, equivalent to $59,481 in current US dollars. This estimate amounts to about 75 percent of the value of the fixed capital stock for a firm of average size.[23] The entry cost reflects the bureaucratic costs associated with creating a new firm, capital installation and removal costs, as well as any customizing of equipment and facilities that does not add to their market value. Its magnitude seems plausible, given the finding that bureaucratic costs alone amounted to 19 percent of Colombian per capita income in 2007 (World Bank, 2008).[24] Fixed costs amount to exp(4.9175) =136,661 in 1977 pesos, or $8,297 in current dollars These

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$I_t = I_0 (1-x)^t + eN \left(\dfrac{1-(1-x)^t}{x} \right)$. Thus, with stable rates of entry and exit, the current population approaches

eN/x as $t64$, and the size of the initial population becomes irrelevant. Similarly, the asymptotic entry rate and exit rate depend only on e and x. Experiments show that, holding other parameters fixed, variations in the number of new potential entrants per period have very little effect on the simulated moments.

[23] In 1977, there were 46.11 pesos per dollar. Also the U.S. GDP deflator was about 36 percent of its value in 2007. We use these two statistics to translate 1977 Colombian pesos into current U.S. dollars.

[24] By way of crude comparison, Hurst and Lusardi (2004) report that the median start-up equity investment among entrepreneurs creating manufacturing businesses in the United States was $47.300 in 1984.

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expenditures are incurred every year, regardless of production levels; they include various overhead expenses like insurance, marketing, and legal representation.

Non-asset household income (y) is estimated to be 187,729 in 1977 pesos, or \$11,396 in current dollars, and the average initial wealth of a new entrepreneur (assuming a lognormal distribution) is estimated at $\exp(\overline{\ln a_0} + s^2_{\ln a_0}/2) = 324{,}294$ in 1977 pesos, or \$19,686 in current dollars. The average initial wealth of new entrepreneurial households implies that new entrepreneurs have to borrow in order to create a new business. However, since there is significant variation around this mean $(s^2_{\ln a_0} = 1.1083)$, it does not imply that those who actually create businesses leverage themselves heavily. The estimated credit market imperfection index (2) is essentially unity, suggesting that creditors view themselves as incapable of extracting any value from collateralized assets in the event of default. Put differently, creditors view households as capable of absconding with the entire value of their firms' productive assets if they choose to do so. One should bear in mind that, since 2 is identified by the borrowing levels of firms at different (υ,k) combinations, it will tend toward unity whenever the data imply that borrowing levels are low at small, highly profitable firms. Hence, although information asymmetries and costly state verification are not part of our model, they may well help explain the large 2 value that we estimate. In any case, our finding is consistent with the World Bank's (2008) assessment that there are severe enforcement problems in Colombian credit markets (refer to footnote 8). Further, as the simulated moments indicate, the model does a reasonably good job of explaining the borrowing patterns observed in the data. It predicts equilibrium borrowing at 2 =1 because, by not defaulting, borrowers keep open the option of operating a business in the future without incurring entry costs.

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Finally, it is worth noting that our estimate of the risk aversion parameter, σ, is at the low end of the figures that are used in the macro literature. This may reflect the fact that our model identifies this parameter off the behavior of entrepreneurial households, while econometric studies of risk aversion commonly use samples household survey data (e.g., Attanasio and Browning, 1995). As Hurst and Lusardi (2004) argue, households with relatively high tolerance for risk are likely to self-select into entrepreneurship.

IV.   Industry Structure, Wealth Distributions and Credit Market Imperfections

Given all of the parameter estimates discussed above, we can now use simulations to answer three basic questions. [25] First, how might industry and household characteristics change if collateral could be committed to banks with complete credibility and no transactions costs? Second, how do credit market imperfections affect industry and household characteristics during regime 1 (strong, volatile currency and low interest rates) versus regime 2 (weak, relative stable currency and high interest rates)? And finally, how has the large spread between borrowing and lending rates affected industry and household characteristics?

A.   Ability to Enforce Debt Contracts

To characterize industry equilibria under different credit market conditions, we twice simulate the model for 80 periods, generating a "base case" and a "counterfactual" pattern of industrial evolution. Then, throwing out the first 30 periods of both simulations as a burn-in, we construct moments that summarize the average industry state under each scenario. The base case

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[25] To perform these simulations, it is necessary to assume an initial distribution of potential entrant firms over asset levels, $h^N(a_{it})$, and an initial distribution of incumbent owner-households over asset levels and productivity levels, $h^I(a_{it}, n_{it})$. We let the former be lognormal with the parameter values reported in table 3, and we . . . (further details?) Since we discard the first 30 years of simulated data, the results proved to be insensitive to these assumptions **(confirm or delete).**

simulation sets 2 equal to its estimated value of 1, implying that lenders have no ability to

recover if the firm chooses ot default on loans. The "counterfactual" simulation sets 2 = 0,

implying that creditors can are unable to always get the full market value of the borrower's

collateral in the event of default.

　　Table 4 summarizes the results. When lenders can perfectly enforce loan contracts, firms

are naturally able to borrow more. Thus the simulations imply that reducing 2 from one to zero

increases the fraction of firms that carry debt (from 71 percent to 73 percent), and increases the

average debt-to-asset (leverage) ratio among borrowers (from 33 percent to 39 percent). The

improvement in credit market conditions also results in a 4 percent reduction in the mean wealth

level of firm owners, reflecting the fact that entrepreneurs can enter with less equity—and need

less time prior to entry to accumulate savings—when credit is more readily available.

　　These effects translate into a 5.2 percent improvement in the size-weighted profitability

of firms. Part of this improvement is due to selection, as more of the least productive firms drop

out. That is, leaving and re-entering is less costly when sunk costs entry can be financed with

loans, so some marginal firms exit and the average firm's lifespan falls by 0.2 years.[26] Another

part of the improvement comes from the fact that some rationed firms with high return projects

are better able to expand. This is apparent from the increase in covariance between size and

profit shocks (from 0.97 to 1.13), and from the substantial reduction in correlation between

wealth and firm size (from 0.71 to 0.43). Overall, credit markets that perform poorly because of

lack of enforcement of loan contracts lead to non-trivial efficiency losses.

B.　　Loan enforcement effects under alternative macro regimes

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[26] The exit of marginal firms causes the average profitability index (v) of exiting firms to increase from -0.692 to -0.681.

Next we investigate whether the effects of credit market imperfections are similar during the different macro regimes identified by our switching VAR. We do this by simulating the model over 280 periods, throwing out the initial 30 periods as a burn-in. Then we average values of the various statistics for all periods during which regime 1 prevailed, and for all periods when regime 2 prevailed. Agents are presumed to correctly perceive that switching patterns are governed by the estimated switching threshold of $r = 9.4$ percent.

The first two columns of table 5 summarize the regime 1 and regime 2 results for the base case of 2=1 and the latter two columns do the same for counterfactual case of 2=0. Most variables are fairly insensitive to the regime, regardless of credit market conditions. This is because interest rates and exchange rates move in opposite directions when regimes change, and their effects on households' net earnings after interest tend to offset each other. (The average log exchange rate and interest rate are 4.82 and 0.06, respectively, in regime 1, while they are 4.60 and 0.159, respectively, in regime 2.)

Interestingly, however, the covariance between wealth (a) and firm size (k) reacts differently to macro volatility under different credit market assumptions. Exchange rates are more volatile in regime 1 than regime 2, and interest rates are equally volatile in both regimes, so switching from the first regime to the second reduces the relative volatility of business income. When credit markets function poorly (i.e., when 2=1), volatility in business income is closely linked to volatility in household consumption. And since low-a households are especially risk-averse, volatility makes them reluctant to hold much of their wealth in proprietorships, even if they have high v's. This is why the covariance between a and k is larger under regime 1 than under regime 2 when 2=1. On the other hand, well-functioning credit markets allow low-a households to better smooth their consumption during periods of volatile business income. This

encourages low-*a*, high-*v* households to hold more of their wealth in proprietorships under regime 1, weakening the link between *a* and *k*.

That regime switches affect different households in different ways is more explicitly demonstrated by figures 3a through 3c Figure 3a depcts the difference in valueof incumbent firms between regimes 1 and 2 to households with different (a, v) combinations when $\theta = 1$. Figure 3a indicates that households with high wealth levels prefer regime 2, whereas firms wi th low wealth levels will prefer regime 2. This results from the fact that high wealth households tend to be net lenders in capital markets, and thus tent to prefer the regime in which interest rates are high. This can be seen most clearly by considering the incumbent households with the lowest level of productivity, which will exit in almost all states and wealth levels. The value function for incumbent households will will thus reflect the exit payoffs in the respective regimes at the lowest productivity levels. Since the payoff in the exit state is increasing in the return earned on assets, the exit payoff is higher in regime 2 and the differential is increasing in the wealth level of households. For incumbent households with very low asset levels t he primary source of income is production income and these households must borrow to finance capital investments when productivity levels are sufficiently high that they do not exit. These households will prefer regime 1 where borrowing rates are lower, a nd this preference will be increasing in the productivity level. .[27] Interestingly, low wealth households prefer a regime with low interest rates, despite the stiffer product market competition from abroad that the strong exchange rate implies. For households with both high wealth levels and high productivity levels, Figure 3c shows that the lending effect dominates leading to a preference for regime 2.

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[27] This findings is similar to Gine and Townsend's (2004), whose simulations imply that the primary beneficiaries of improvements in the Thai financial sector are "talented would-be entrepreneurs who lack credit and cannot otherwise go into business (or invest little capital)." (p. 269)

Figure 3b shows that a similar household preference over regimes for the case $\theta = 0$ with perfect enforcement of loan contracts. The role of loan enforcement on preferences can be be seen in Figure 3c, which is constructed as the difference between figures 3a and 3b It shows that improvements in credit market efficiency don't significantly affect the change in payoffs that accrue to wealthy households as the economy moves between regimes, because these households can self-finance much of their capital investment and are non credit constrained when contract enforcement is weak. However, improvements in enforcement do help low-a, high-v households through periods when they would like to be borrowing more in regime 1 environments.

C. The Effects of the Borrowing/Lending Spread

As a final exercise, we explore the effects of more efficient financial intermediation in a different sense: lower spreads between borrowing and lending rates, μ. For non-entrepreneurial households, it can be seen from (1) that the first order effect of a small reduction in μ will be to raise the value of current income by an amount proportional to the household's asset holdings. For incumbent firms that are constrained in the credit market, a reduction in μ will have a first order effect of reducing consumption by an amount that is proportional to $max(a_{it} - k_{it}, 0)$ from (4). For incumbent firms that are borrowing, the reduction in the spread has no effect on income because all of the household's assets are invested in the firm and receiving a return of r. Thus, one of the effects of reducing the spread should be to make exit more attractive for incumbent firms because it raises the return on assets held by non-entrepreneurial households. This should raise the threshold value of productivity required for a firm to remain in the industry, with this effect more pronounced for wealthy households.

To examine the impact of a reduction in μ on the industry, we once again simulate our model forward under a base case scenario (μ=0.06) and a counterfactual scenario (μ=0.02). However, since the reduction in spreads will induce different savings patterns, and the associated changes in wealth trajectories will generate a gradual change in industry structure, for this exercise we explore transition dynamics. More precisely, we simulate the first 140 periods with μ=0.06 and an additional 140 periods with μ=0.02, discarding an initial burn-in period of 30 years. We assume that the reduction in spread is unanticipated, but once it has occurred, households correctly understand that the reduction is permanent.

Figure 4c shows the adjustment in the number of firms that takes place after the spread reduction in period 120. Higher deposit rate attract wealth out of proprietorships and into bank accounts, but the adjustment is gradual because it is accomplished mainly through reduced entry rates during a transition period. This asymmetry in adjustment margins reflects the presence of sunk entry costs, which induce some entrepreneurs to continuing operating firms after the jump in deposit rates, even though they would not have created their firms if they had known the change in μ was coming. The effect of higher deposit rates is more dramatic for the case of well-functioning credit markets (2=0) because, as discussed in section IVA above, these credit conditions encourage exit among marginal firms.

As entrepreneurs move their wealth out of low-return establishments and into bank deposits, the marginal product of business investment rises, driving up the size-weighted average profit shock (v) by more than 3 percent (Table 5 and Figure 4b). Higher deposit rates drive down average firm size too, but only in the case of poorly functioning credit markets (figure 4c). The reason, once again, is that when credit markets function poorly, entrepreneurs have relatively strong incentives to avoid leaving and re-entering. Thus, when confronted with higher deposit

rates, entrepreneurs with relatively unprofitable firms tend to scale them back rather than shut them down.

As with other counterfactual experiments, these simulations show that the effects are not distributed evenly across different types of households. Figure 4d shows that the main adjustment in terms of portfolio reallocations toward bank deposits comes among high-productivity firms held by wealthy households. These households own businesses, and not being credit-rationed, they were equating returns at the margin between their business investments and bank deposits before the reform. Accordingly, when the deposit rate rises, this group adjusts.

V.   Summary

We have developed an empirical model that characterizes the effects of macroeconomic volatility, poorly functioning credit markets, and substantial entry costs. Applied to panel data on Colombian apparel producers, the model yielded econometric estimates of a loan enforcement index, the sunk costs of creating a new business, and various other parameters. It also provided a basis for counter-factual simulations of the effects of improving contract enforcement and reducing the spread between borrowing and lending rates. These simulations highlighted the differential impact of improvements in the operation of credit markets on high and low wealth households. Both the spread between lending and borrowing rates and the lack of contract enforcement provide an incentive for firms to self-finance their investments, which provides an advantage to high wealth households. Improving contract enforcement reduces the advantage of high wealth households, and raises the average productivity of firms in the industry because it results in a more effective sorting of firms on the basis of productivity. The simulations also illustrated the interaction between improved enforcement and macro volatility, because low

wealth households benefited most from improved contract enforcement in the low interest rate regime where the credit constraint was most binding. A narrowing of the spread between borrowing and lending rates also served to reduce the advantage of self-financing, which reduced the correlation between the level of wealth and the firm's choice of capital in the new industry equilibrium. . The results provided micro-based confirmation of the common finding that countries with relatively well-functioning financial markets grow relatively rapidly (Levine, 2005).

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A. Sources of identification

From (10c) in the text, the expectation of the profit shock n_{it} conditioned on the macro state, predetermined variables, and continuation ($\mathsf{c}_{it} = 1$) is:

$$E(\mathsf{n}_{it} \mid s_t, a_{it}, v_{it-1}, \mathsf{c}_{it} = 1) = \mathsf{l}\,\mathsf{n}_{it-1} + E(\mathsf{e}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}, \mathsf{c}_{it} = 1)$$

Thus, using (10a) – (10c), the following errors have mean zero and are orthogonal to the vector of conditioning variables:

$$\mathsf{x}_{it}^{R} = \ln G_{it} - (\mathsf{h}_0 + \mathsf{h}_1 \ln e_t + \mathsf{h}_2 \ln k_{it}) \\ - \mathsf{l}\,\mathsf{n}_{it-1} - E[\mathsf{e}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}; \mathsf{c}_{it} = 1] \tag{A1}$$

$$\mathsf{x}_{it}^{C} = \ln C_{it}^{*} - (\mathsf{h}_0 + \ln \mathsf{t} + \mathsf{h}_1 \ln e_t + \mathsf{h}_2 \ln k_{it}) \\ - \mathsf{l}\,\mathsf{n}_{it-1} - \mathsf{z}_{it}^{C} - E[\mathsf{e}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}; \mathsf{c}_{it} = 1] \tag{A2}$$

$$\mathsf{x}_{it}^{\mathsf{n}^2} = [\mathsf{n}_{it} - E[\mathsf{n}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}; \mathsf{c}_{it} = 1]]^2 \\ - \mathrm{var}[\mathsf{n}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}; \mathsf{c}_{it} = 1] \tag{A3}$$

and the associated moment conditions provide a basis for identifying the profit function parameters and the transition density, $f(\mathsf{n}_{it+1} \mid \mathsf{n}_{it})$:[28]

$$\mathsf{x}_{it}^{R} \perp (s_t, a_{it}, \mathsf{n}_{it-1}), \quad \mathsf{x}_{it}^{C} \perp (s_t, a_{it}, \mathsf{n}_{it-1}), \quad E(\mathsf{x}_{it}^{R}) = E(\mathsf{x}_{it}^{C}) = E(\mathsf{x}_{it}^{\mathsf{n}^2}) = 0 .$$

To construct $E(\mathsf{e}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}, \mathsf{c}_{it} = 1)$ and $\mathrm{var}(\mathsf{n}_{it} \mid s_t, a_{it}, \mathsf{n}_{it-1}, \mathsf{c}_{it} = 1)$, we express the continuation probability as:

---

[28] Note that beginning-of-period assets, a_{it}, are predetermined, but k_{it} depends upon n_{it} and is therefore excluded from the conditioning set, $(s_t, a_{it}, \mathsf{n}_{it-1})$.

$$p_{it} = \underline{P[c_{it} = 1 \mid s_t, a_{it}, v_{it-1}]} = \int_{\underline{n}(s_t, a_{it})}^{\infty} \frac{1}{s_e} f\left(\frac{n' - \ln n_{it-1}}{s_e}\right) dn'$$

$$= \int_{\underline{n}(s_t, a_{it}) - \ln n_{it-1}}^{\infty} \frac{1}{s_e} f\left(\frac{e_{it}}{s_e}\right) de_{it} \; ,$$

where $f()$ is the standard normal density function. Then, given p_{it}, the standard formulae for

moments of truncated normal distributions imply (e.g., Maddala, 1983):

$$E(e_{it} \mid s_t, a_{it}, n_{it-1}, c_{it} = 1) = s_e M_{it} \tag{A4}$$

$$\text{var}(n_{it} \mid s_t, a_{it}, v_{it-1}, c_{it} = 1) = s_e^2 \left(1 - M_{it} \cdot [M_{it} - \Phi^{-1}(p_{it})]\right), \tag{A5}$$

where $M_{it} = \dfrac{f\left(\Phi^{-1}(p_{it})\right)}{p_{it}}$ is the relevant Mills ratio and $\Phi()$ is the standard normal cumulative
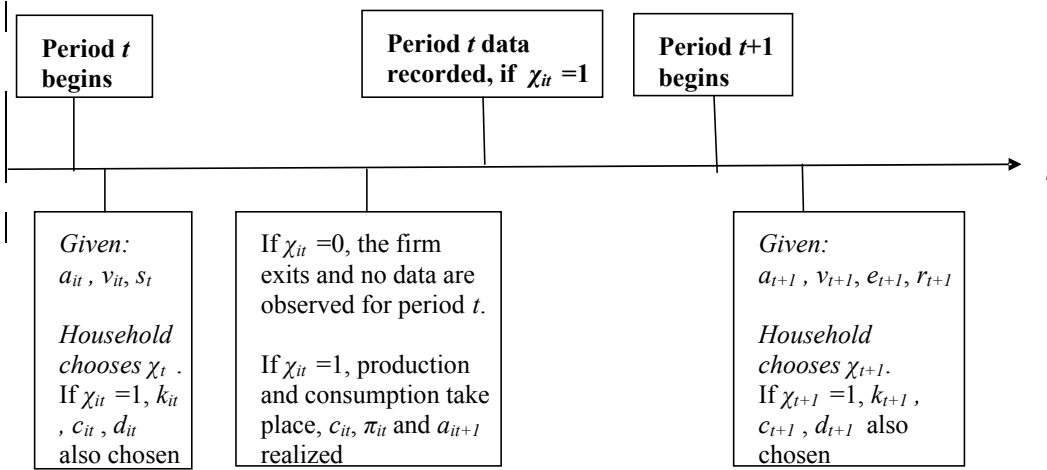
distribution function. Parameterizing $\underline{n}(s_t, a_{it})$ as a flexible function in its arguments (with time

dummies controlling for the macro state), then substituting A4 into A1 and A2, and substituting

A5 into A3, one obtains moment expressions in terms of data and parameters.

B.   Dealing with unobserved asset stocks

To implement the estimation strategy sketched above, one must deal with several issues

concerning a_{it}. The first is that a_{it} is never observed for the firms exiting in period t. (Refer to the

time line in figure A1 below.) This problem is easily surmounted because, given the macro state,

s_{t-1}, all households with the same (a_{it-1}, v_{it-1}) values make the same capital choices and

consumption decisions, and begin period t with the same a_{it}. Therefore, the vector (a_{it-1} v_{it-1}, s_{t-1})

implies (a_{it}, v_{it-1}) for any firm that is not rationed, and we can replace the latter vector of

conditioning variables with the former.

Period *t* begins	Period *t* data recorded, if $\chi_{it}=1$	Period *t+1* begins

$\longrightarrow$ *t*

Given: a_{it} , v_{it}, s_t *Household chooses* χ_t . If $\chi_{it}=1$, k_{it} , c_{it} , d_{it} also chosen	If $\chi_{it}=0$, the firm exits and no data are observed for period *t*. If $\chi_{it}=1$, production and consumption take place, c_{it}, π_{it} and a_{it+1} realized	*Given:* a_{t+1} , v_{t+1}, e_{t+1}, r_{t+1} *Household chooses* χ_{t+1}. If $\chi_{t+1}=1$, k_{t+1} , c_{t+1} , d_{t+1} also chosen

The second problem is that the data set does not *directly* report a_{it} values for any period. We deal with this problem in different ways for different types of firms. For all firms that carry positive debt (d_{it}), our model implies that $a_{it} = k_{it} - d_{it}$ because no household has an incentive to simultaneously borrow and hold bank deposits. For firms with no debt, assets can similarly be inferred $a_{it} = k_{it} - d_{it} = k_{it}$, so long as the owner is credit rationed; that is, so long as the firm's marginal revenue product of capital exceeds the deposit rate:

$$MRP_{it} = \frac{h_2}{m}\exp(h_1 \ln e_t + n_{it})\cdot(m^{-1}-1)(k_{it})^{h_2-1} - d > r_t - m^d,$$

or equivalently,

$$n_{it} > b(k_{it},s_t) \equiv \ln\left[\frac{(r_t - m_d + d)m}{h_2(1-m)}\right] + (1-h_2)\ln k_{it} - h_1 \ln e_t. \qquad (A10)$$

Given any set of parameter values, this conditioned can be checked, observation by observation.

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Finally, for non-rationed firms that carry no debt, owners' beginning-of-period assets cannot be inferred from the data. But k_{it} still helps to predict their exit thresholds, since it bounds assets from below $(a_{it-1} > k_{it-1})$, and therefore contains information about households' willingness to continue operating proprietorships. We therefore express these firms' threshold profit shocks as $\underline{n} = \underline{\tilde{n}}(s_t, k_{it-1}) + z_{it}$, where $\underline{\tilde{n}}(s_t, k_{it-1})$ is the projection of $\underline{n}(s_t, a_{it})$ on a flexible function of (s_t, k_{it-1}), and z_{it} is the noise in this projection. That is, when (A10) fails to hold and a firm holds no debt, the continuation probability can be written as:

$$p_{it} =$$

$$\begin{cases} \Pr[n_{it} \geq \underline{\tilde{n}}(s_t, k_{it-1}) + z_{it}] = \Pr[e_{it} - z_{it} \geq \underline{\tilde{n}}(\cdot) - \ln_{it-1}], & d_{it} = 0, n_{it} \leq b(k_{it}, s_t) \\ \Pr[n_{it} \geq \underline{n}(s_t, k_{it} - d_{it})] = \Pr[e_{it} \geq \underline{n}(\cdot) - \ln_{it-1}], & \text{otherwise} \end{cases}$$

Then, further assuming that z_{it} is normally distributed, (A8) and (A9) generalize to:

$$E(e_{it} \mid s_t, k_{it} - d_{it}, v_{it-1}, c_{it} = 1) =$$

$$\begin{cases} \dfrac{s_e^2}{\sqrt{s_e^2 + s_z^2}} M_{it} & \text{for } d_{it-1} = 0, n_{it} \leq b(k_{it}, e_t, r_t) \\ s_e M_{it} & \text{otherwise} \end{cases} \qquad \text{(A4')}$$

$$\text{var}(n_{it} \mid e_t, r_t, a_{it}, v_{it-1}, c_{it} = 1) =$$

$$\qquad \text{(A5')}$$

$$\begin{cases} (s_e^2 + s_z^2)\left(1 - M_{it} \cdot [M_{it} - \Phi^{-1}(p_{it})]\right) & \text{for } d_{it-1} = 0, n_{it} \leq b(k_{it}, e_t, r_t) \\ s_e^2\left(1 - M_{it} \cdot [M_{it} - \Phi^{-1}(p_{it})]\right) & \text{otherwise} \end{cases}$$

Our estimator sorts firms according to whether assets are unobserved or not—i.e., whether the conditions $d_{it} = 0$ and $v_{it} \leq b(k_{it}, s_t)$ hold—applying (A4') and (A5') accordingly in the calculation of the sample moments. At the estimated parameter vector, assets are imputable for 84 percent of the sample observations. (That is, 84 percent of the observations were on firms with positive debt levels, rationing, or both.) Also, 24 percent of the observations were found to be rationed.

Table 1: SETAR Switching Model Parameters[a]

	Regime 1		Regime 2	
	e	*r*	*e*	*r*
b_0	0.022	0.326	0.187	-0.101
	(0.242)	(0.133)	(0.166)	(0.075)
b_1	0.992	-0.062	0.962	0.030
	(0.048)	(0.026)	(0.037)	(0.017)
	0.313	0.517	-0.094	0.761
	(0.313)	(0.169)	(0.175)	(0.079)
Σ	1.75e-3	-9.41e-5	1.44e-3	-1.7e-4
	-9.41e-5	5.28e-4	-1.7e-4	2.97e-4
Threshold *r*		0.094		
Log likelihood		427.62		

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[a]Based on quarterly IFS data for Colombia, 1982-I through 2007-II. Standard errors are in parentheses.

Table 2: Operating Profit Function Parameters, Colombian Apparel Producers[*]

	Coefficient	Std. Error	Z-ratio
Intercept, revenue equation (0_0)	6.051	0.325	18.627
Intercept, cost equation ($0_0 + ln J$)	5.832	0.325	17.956
Exchange rate (0_1)	-0.370	0.050	-7.341
Capital stock (0_2)	0.605	0.034	17.534
Root of < process (8)	0.895	0.008	111.158
Variance of innovation in< process (s_e^2)	0.415	0.011	38.934
Depreciation rate ($*$)[**]	0.093	0.004	23.650
Number of observations		10,340	

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[*]GMM estimates of the system (11a), (11b), (11c), (11d).
[**]Estimated separately as the average (book value) depreciation rate.

Table 3:
Parameters Identified by the Dynamic Programming Problem (7)

	Parameter	Std. Error	Z ratio
Exogenous income (y)	187.729	101.036	1.858
Fixed costs (f)	136.661	36.516	3.743
Sunk entry costs (F)	979.753	81.613	12.005
Credit market imperfection index (2)	1.000	0.018	54.615
Risk aversion parameter (σ)	0.572	0.117	4.901
Average log assets, new entrepreneurs ($\overline{\ln a_0}$)	5.228	0.149	35.131
Variance in log assets, new entrepreneurs ($s^2_{\ln a_0}$)	1.108	0.225	4.919
Probability of new business opportunity (p)	0.945	0.289	3.267
Ratio of total productive assets to fixed assets (8)	6.313	0.003	1856.853

	Simulated Moment	Sample Moment
Expected value of log capital stock	6.505	6.193
Variance of log capital stock	1.455	2.102
Expected value of log operating profits	7.129	6.801
Variance of log operating profits	1.755	2.048
Expected value of log debt (given debt is positive)	-1.134	-0.878
Variance of log debt (given debt is positive)	1.699	2.449
Expected growth in capital stock (net of deprec.)	-0.017	-0.067
Variance of growth in capital stock (net of deprec.)	0.328	0.208
Expected entry rate (expressed as a percentage)	0.138	0.147
Expected exit rate (expressed as a percentage)	0.148	0.156
Variance of entry rate	0.001	0.007
Variance of exit rate	0.001	0.003
Covariance of log capital and log operating profits	1.555	1.143
Covariance of log capital and lagged log capital	1.236	1.948
Covariance of log debt and log capital	0.012	-0.201
Covariance of log debt and log profits	0.227	0.400
Covariance of capital growth rate and log profits	0.086	0.061
Covariance of capital growth rate and log capital	0.199	0.199

Table 4: Industry Characteristics and Loan Enforcement

	2=**1**	2=**0**
Mean Number of Firms	113.767	110.607
Entry Rate	0.146	0.151
Exit Rate	0.147	0.152
Mean Age of Active Firms	9.630	9.643
Mean Profitability	0.758	0.770
Mean Size-Weighted Profitability	3.470	3.650
Mean Covariance Between Size and Productivity	0.970	1.127
Mean Log Capital	6.456	6.772
Mean Investment Rate	-0.015	-0.080
Mean Leverage Among Borrowers	-1.113	-0.942
Percent of Firms with Positive Debt	71.095	72.946
Log of Mean Wealth of Firm Owners	8.514	8.483
Correlation Between Wealth and Capital	0.715	0.434
Exiting and Entering Firms		
Mean Age of Exiting Firms	7.974	7.769
Log of Mean Wealth of Exiting Firms	8.055	7.978
Mean Profitability of Exiting Firms	-0.692	-0.681
Log of Mean Wealth of Entering Firms	7.372	7.371
Aggregate Shocks		
Mean Exchange Rate	4.614	4.614
Variance Exchange Rate	0.004	0.004
Mean Interest Rate	0.141	0.141
Variance Interest Rate	0.001	0.001

Table 5: Loan Enforcement , Macro Conditions and Industry Characteristics

	2=1		2=0	
	Regime 1	*Regime 2*	*Regime 1*	*Regime 2*
Mean Number of Firms	115.255	114.936	102.170	101.855
Entry Rate	0.152	0.146	0.171	0.165
Exit Rate	0.148	0.148	0.166	0.166
Mean Profitability	0.757	0.757	0.796	0.796
Mean Size-Weighted Profitability	3.440	3.449	3.673	3.670
Mean Covariance, Size and Productivity	0.943	0.952	1.100	1.100
Mean Log Capital	6.468	6.457	6.980	6.967
Mean Investment Rate	-0.008	-0.003	-0.079	-0.068
Variance Investment Rate	0.328	0.330	0.486	0.497
Mean Leverage Among Borrowers	-1.082	-1.089	-0.934	-0.923
Percent of Firms with Positive Debt	68.804	68.258	71.974	70.966
Log of Mean Wealth of Firm Owners	8.586	8.595	8.689	8.706
Correlation, Wealth and Capital	0.727	0.713	0.417	0.445
Exiting and Entering Firms				
Log of Mean Wealth of Exiting Firms	8.176	8.171	8.225	8.223
Mean Profitability of Exiting Firms	-0.693	-0.693	-0.650	-0.649
Log of Mean Wealth of Entering Firms	7.363	7.389	7.366	7.389
Aggregate Shocks				
Mean Exchange Rate	4.819	4.596	4.819	4.596
Variance Exchange Rate	0.073	0.065	0.073	0.065
Mean Interest Rate	0.064	0.159	0.064	0.159
Variance Interest Rate	0.005	0.005	0.005	0.005

**Table 6: Loan Enforcment , Interest Rate Spreads and Industry Characteristics**

	2=1		2=0	
	μ= 6%	μ= 2%	μ= 6%	μ= 2%
Mean Number of Firms	112.721	106.328	110.989	98.828
Entry Rate	0.147	0.157	0.150	0.169
Exit Rate	0.148	0.157	0.150	0.170
Mean Profitability	0.757	0.775	0.762	0.803
Mean Size-Weighted Profitability	3.444	3.555	3.629	3.711
Mean Covariance Between Size and Productivity	0.946	1.023	1.122	1.127
Mean Log Capital	6.503	6.410	6.786	6.784
Mean Investment Rate	-0.009	-0.014	-0.076	-0.081
Variance Investment Rate	0.306	0.400	0.503	0.584
Mean Leverage Among Borrowers	-1.158	-1.010	-0.967	-0.824
Percent of Firms with Positive Debt	72.187	66.388	74.552	68.537
Log of Mean Wealth of Firm Owners	8.497	8.647	8.447	8.646
Corr Coef Between Wealth and Capital	0.731	0.666	0.451	0.366
Exiting and Entering Firms				
Log of Mean Wealth of Exiting Firms	8.025	8.269	7.950	8.254
Mean Profitability of Exiting Firms	-0.691	-0.667	-0.685	-0.636
Log of Mean Wealth of Entering Firms	7.372	7.371	7.372	7.370
Aggregate Shocks				
Mean Exchange Rate	4.616	4.614	4.616	4.614
Variance Exchange Rate	0.004	0.004	0.004	0.004
Mean Interest Rate	0.140	0.141	0.140	0.141
Variance Interest Rate	0.001	0.001	0.001	0.001

Figure 1: Transitions between household types
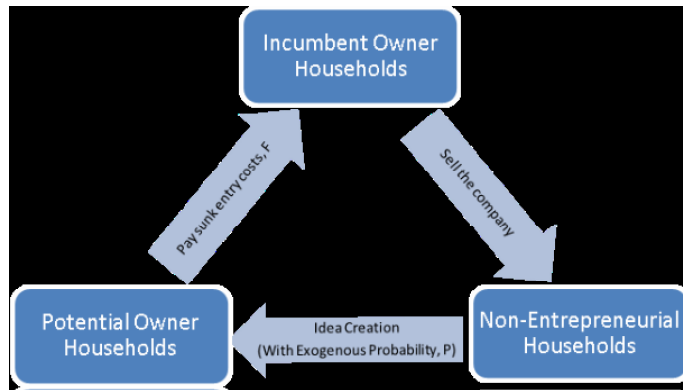
Figure 2: Colombian Exchange Rates and Interest Rates
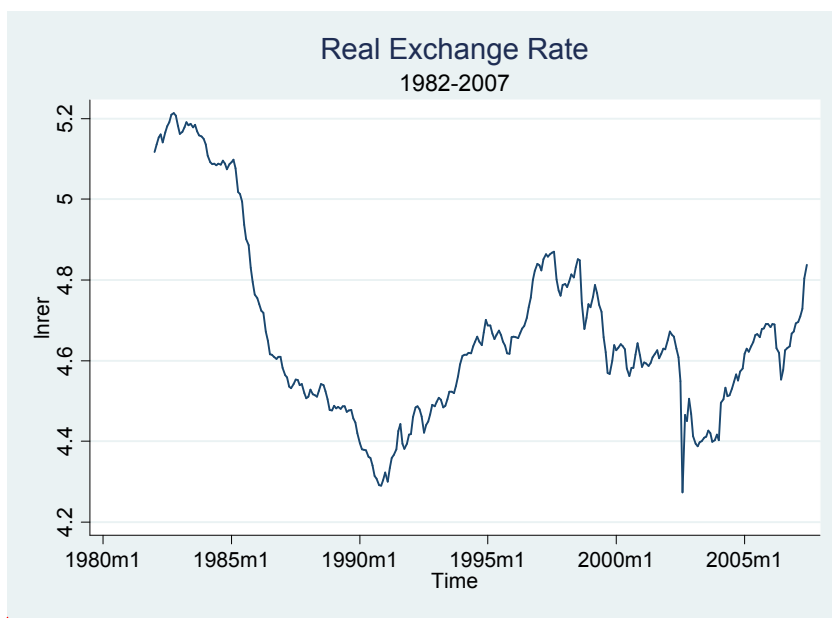
Real Exchange Rate
1982-2007

Real Borrowing Rate
1982-2007
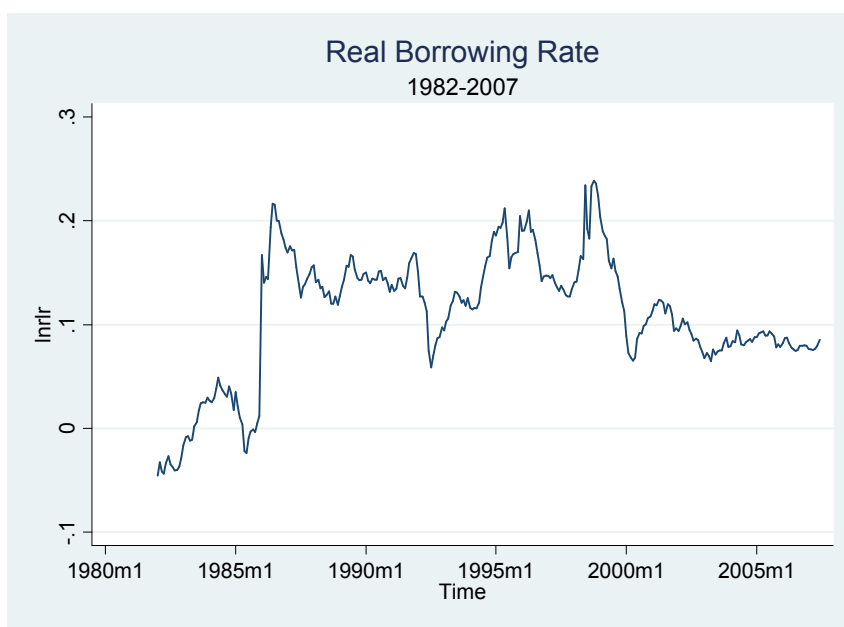
Figure 3a:

Difference Between Value of an Incumbent Firm Owner (Regime 1 -Regime 2) in Base Case
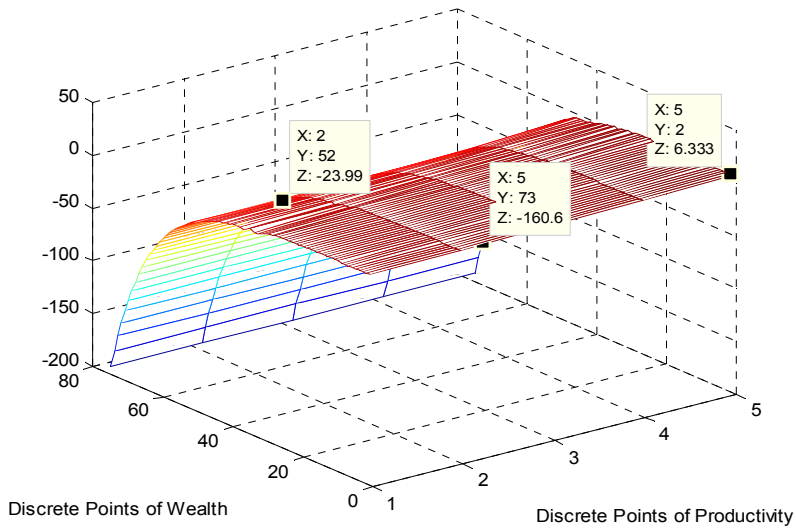
Figure 3b:

Difference Between Value of an Incumbent Firm Owner (Regime 1 -Regime 2) in Theta=0
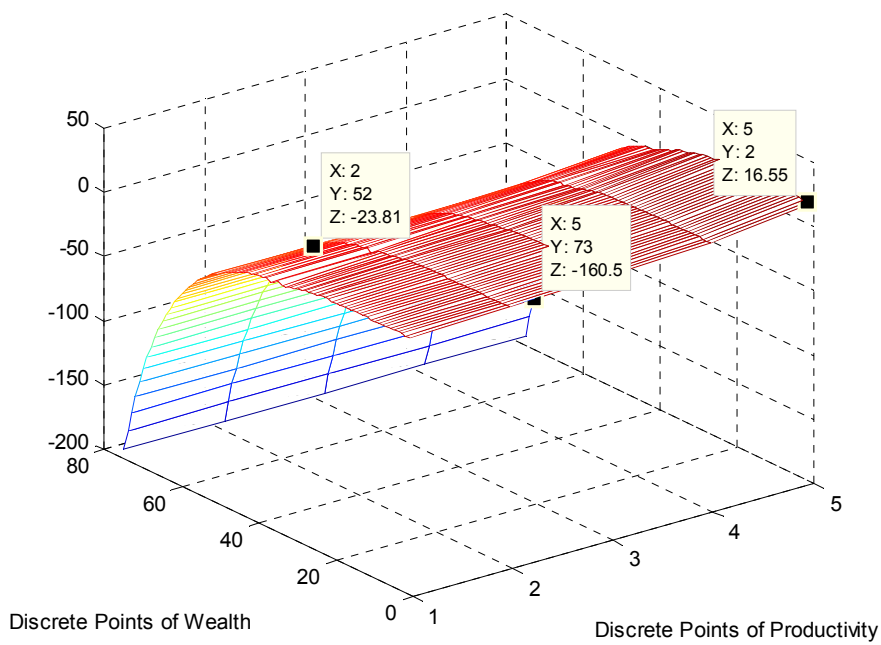
Figure 3c:

Difference in Difference: Theta=0(Regime 1 -Regime 2) - Base(Regime 1 -Regime 2)

Discrete Points of Wealth

Discrete Points of Productivity

Figure 4a:

Evolution of the Number of Firms

Figure 4b:

Average Profitability

Figure 4c:

Average Value of Capital

Base Case
Theta=0

2 % Spread

Time (Year)

Figure 4d:

Differences in Policy Functions for Capital Between 2 % Spread Case and Base Case

Value of Capital

Discrete Points of Wealth

Discrete Points of Productivity

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